ACUTE AND CHRONIC EXPOSURE TO CO_2 IN SPACE FLIGHT

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Spacecraft and space stations, similar to other habitable confined spaces such as submarines, need to provide a breathable atmosphere for their inhabitants. The inevitable production of CO_2 during respiration necessitates life support systems that "scrub" the atmosphere and lower CO_2 levels. Due to operational limitations associated with space flight (limited mass, volume, power, and consumables) CO_2 is not scrubbed down to its terrestrial equivalent of 0.03% CO_2 ($ppCO_2$ of 0.23 mmHg), but is kept below 0.7% (ppCO2 of 5.3 mmHg), a level established in NASA's 180-day mission Spacecraft Maximum Allowable Concentration (SMAC) to be safe and unlikely to cause symptoms. Reports of space flight crewmembers becoming symptomatic with headaches, fatigue, and malaise at levels below those known to cause such symptoms terrestrially has prompted studies measuring the levels of CO_2 on both the space shuttle and the space station. Data from cabin atmosphere sampling were collected on space shuttle missions STS-113, STS-122, STS-123, and International Space Station Expeditions 12-15 and 17, and the measured CO_2 levels were then correlated to symptoms reported by the crew. The results indicate that a correlation exists between CO_2 levels and symptomatology, however causality cannot be established at this time. While the short-term effects of elevated CO_2 exposure are well known terrestrially, less is known regarding potential long-term effects of prolonged exposure to a CO_2-rich environment or how the physiological changes caused by microgravity may interact with such exposures. Other challenges include limitations in the CO_2 monitors used, lack of convection in the microgravity environment, and formation of localized CO_2 pockets. As it is unclear if the unique environment of space increases sensitivity to CO_2 or if other confounding factors are present, further research is planned to elucidate these points. At the same time, efforts are underway to update the SMAC to a lower level.

Learning Objectives: The audience will become familiar with the challenges of maintaining CO_2 levels in space craft and space stations, and with study data collected in flight correlating CO_2 levels with crew symptomatology.